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the basin, the occurrence of marsh-formed or land-formed lignites in similar situations, the interstratification of beds of gypsum or other desiccation products, and analogous criteria that imply aerial conditions.

T. C. C.

The Crystal Falls Iron-Bearing District of Michigan. By J. MORGAN CLEMENTS and HENRY LLOYD SMYTH, with a chapter on the Sturgeon River Tongue by William Shirley Bayley and an Introduction by Charles Richard Van Hise. U. S. Geological Survey. Monograph XXXVI. Washington, 1899.

This report is the third in a series of four monographs on the iron-bearing district of the Lake Superior Region. Two having been published previously: one on the Penoee district (Monograph XIX). The other on the Marquette district (Monograph XXVIII). The fourth, on the Menominee district, is to follow.

The Crystal Falls district was divided areally, the western half being studied by Mr. Clements and the eastern half by Mr. Smyth, and the Sturgeon River Tongue by Mr. Bayley. The investigation was conducted under the charge of Mr. Van Hise, who sums up the general results in an introductory chapter. The district embraces 840 square miles. As pointed out in the introduction the rocks belong to the Archean and Algonkian. The latter consisting of a Lower Huronian and an Upper Huronian separated by unconformity. The Archean is believed to be wholly igneous in origin, it occupies a broad area in the eastern part of the district and has not been closely investigated. Several smaller areas occur within parts of the region carefully studied. Owing to the readily decomposable nature of the rocks in places and to the drift mantle the detail character of the formations is unknown for part of the area described by Clements, and in the belt worked by Smyth the rock surface is almost wholly concealed by glacial deposits and vegetation. It will be seen under what adverse circumstances the field work was carried forward, and how much credit is due the geologists who have brought to light so much valuable information from so unpromising a region.

The Lower Huronian consists of quartzite, dolomite, slate, a volcanic formation, and some schists. The series has a minimum thickness of 2200, and a possible maximum thickness of 16000 feet. The sediments probably nowhere exceed 5000 feet in thickness. The Upper Huronian

is a great slate and schist series, not separable into individual formations, and whose thickness cannot be approximately estimated. All of these formations have been cut by igneous rocks of various kinds and at different epochs.

Metamorphism has greatly altered the character of the Algonkian rocks. In the Lower Huronian the quartzite is the altered form of a sandstone and conglomerate in which the pebbles have been nearly destroyed. It is in places schistose. The dolomite is a nonclastic sediment. The slate or schist is an altered mudstone. The volcanic formation is perhaps the most characteristic feature of the Crystal Falls district. It occupies a larger area than the other Lower Huronian formations and consists of basic and acid rocks, lavas and tuffs, with subordinate interbedded sedimentary rocks. The iron-bearing formation, called the Groveland, consists of sideritic rocks, cherts, jaspillites, iron ores, and other varieties characteristic of the iron-bearing formations of the Lake Superior region.

After elevation and unequal erosion of the Lower Huronian, conditions of deposition covered these formations with sandstone and slate conglomerate, passing upwards into shales and grits, subsequently altered to mica-slates and mica-schists. These were followed by combined clastic and non-clastic sediments, the latter including iron-bearing carbonates. Above these is a great thickness of mica-slates and mica-schists.

After a long period of deposition a profound physical revolution occurred, raising the region and folding it in a most complex manner. The folds have steep pitches indicating great compressive stresses in all directions tangential to the surface of the earth. Subsequent to or during the late stage of this time of folding there was a period of great igneous activity, probably contemporaneous with the Keweenaw, intruding within the rocks vast bosses and numerous dikes of peridotites, gabbros, dolerites and granites. These intrusives, while altered by metasomatic changes, do not show marked evidence of dynamic metamorphism.

Subsequently the region was subjected to great denudation and reduced approximately to its present configuration. In late Cambrian time Upper Cambrian sediments were deposited upon it. Whatever may have been deposited upon the Cambrian has been removed by erosion together with most of the Cambrian. If the region was again submerged in Cretaceous times no evidence of the fact remains.

During the Pleistocene period a thick mantle of glacial deposits was spread over the entire area, which has been eroded far enough to uncover the rocks here and there.

Clements's description of the western part of the district treats of the surface features, the economic resources and the petrographical character of the various formations, especial attention being paid to the volcanic rocks. The great abundance of volcanic breccias and tuffs indicates the probable existence in Huronian time of a volcanic cone in this region, but the possible location of its vent has not been discovered. A small part of the igneous rocks are acid, their area being too small to map on the scale of publication. They include rhyolite-porphyrries and aporhyolite-porphyrries and breccia of the latter. The great part of the volcanics are metabasalts and breccias of the same. An interesting development of ellipsoidal structure is noted. The pre-Cambrian intrusive rocks include granites and rhyolite-porphyry, metadolerite, meta-basalt and picrite-porphyry, besides a series considered to be closely connected genetically ranging from granite, tonalite and quartz-mica-diorite through diorite, gabbro, and norite to peridotite. The diorite is closely related to monzonite.

In the second part of the monograph Smyth discusses at length the effect of buried magnetic ores on the magnetic dip needle, describes its use and the results of careful observations in locating the iron-bearing deposits. He also describes the different formations structurally and petrographically. The same is done by Bayley for the Sturgeon River Tongue.

J. P. I.

The Geography of Chicago and its Environs. By ROLLIN D. SALISBURY and WILLIAM C. ALDEN. Bulletin No. 1 of the Geographic Society of Chicago, published by the Society. Chicago, 1899. 64 pp.

This pamphlet is a model essay on local geography written in an interesting style and illustrated in an attractive and instructive manner. From the maps and descriptions it is learned that Chicago is situated on a plain which stretches from Winnetka, sixteen miles north, to Dyer, about twenty-eight miles south of Chicago, and sweeps eastward around the southern end of Lake Michigan. This plain is narrower at its extremities and has a maximum width of fifteen miles in about the latitude of Chicago; it is limited on the east and northeast by Lake